Assistance in Case of Accidents with Ammonia

1. Possible Causes

Regular inspections of the relevant safety features in an ammonia refrigeration plant are part of complying with the (legal) requirements, especially as set out in the German Federal Emissions Control Act (BImSchG). According to Section 15, repeated checks must be performed either by an "authorized person" as defined in Section 2, § 7 of the Occupational Health & Safety Act (BetrSichV) or by a certified inspection authority. Regardless of the refrigerant used, the operator shall ascertain the inspection deadlines for the overall facility and its parts based on a safety assessment. As with any technical facility, even this will not rule out the occurrence of incidents, though it may be said in general that the most frequent causes are the result not of faulty materials, but of handling errors. The following outlines some typical factors that basically apply for all refrigerants, but of which a special note is made because of the specific characteristics of ammonia.

1.1 Draining the Oil / Degreasing

On the one hand, there are refrigerator oils that are both soluble in ammonia and hygroscopic and which have been used for some time now especially in compact refrigeration units. On the other, there are "classical" DIN 51503, Group KAA refrigerator oils, which are not soluble in ammonia. The following remarks apply especially for this latter group.

In addition to a recommended automatic oil return the lowest point of the oil separator offers the possibility to separate by manual operation. The manual oil removal works in the form of a stop valve with a downstream quick-action valve which is kept open during the draining process by a quick-action lever. Please note that:

- Oil may only be drained by operating staff familiar with the system.
- Oil must always be drained with great care. Always use a gas mask and rubber gloves and make sure that your skin doesn't come into contact with liquid refrigerants.
- The pressure of the oil receptacle from which the oil is to be taken must exceed the atmospheric pressure. If regular operating pressure lies below atmospheric pressure, the oil must be drained during a defrosting period or while the facility is shut down – or the system must have an oil lock.

- If no oil runs out when the stop valve is fully opened and the quick-action valve is slightly open, the latter must be closed again immediately. Never try to open up passage from the outside. Instead pump the ammonia out of the vessel to be degreased, render the vessel completely free of ammonia and dismantle the stop valve including the quick-action valve.
- Regular degreasing will prevent the formation of dirt plugs and the need for cleaning the valve as mentioned above.
- The operating staff may not leave the site of the degreasing while draining the oil.
- The quick-action lever may not be jammed while draining the oil, e.g. by propping it up with sticks or tying it up with wire.

1.2 Bleeding the air from the system / De-aeration

Air in the system leads to a higher liquefaction pressure and hence to higher energy consumption. Possible reasons for air in the system are:

- Carelessness (air sucked in) while drawing in oil and / or refrigerant
- Leaks on the low-pressure side of systems operating below atmospheric pressure

Protective gloves and a gas mask must be worn when manually de-aerating the system. An automatic de-aerator eliminates the need to manually bleed the system.

1.3 Lack of relief systems to contain expanding liquid

Facilities in which the solenoid valve / nonreturn valve combination in liquid-lines is installed in the wrong sequence are a recurring problem. In the direction of flow, the solenoid valve should come first, followed by the nonreturn valve. If the sequence is reversed, liquid is trapped between the nonreturn valve and the solenoid valve when the solenoid valve is shut off. The liquid heats up during the standstill and its expansion may cause pipes or connecting flanges to rupture. This applies for lines that conduct cold liquids.

1.4 Shutting down the refrigerant pumps

There have been several incidents as a result of liquid refrigerants trapped in refrigerant pumps, e.g. when an operating pump was switched to a back-up pump. If the operating pump goes from operating condition to being cut off on both sides, liquid, cold refrigerant remains trapped in the pump. During standstill, the refrigerant in the pump heats up, leading to leakages through ruptures in the casing or flange.

1.5 Opening drainage taps

Heat transmitters usually have drainage taps equipped with screws for the different chambers. Before removing a drainage screw, please make sure that the one it leads to is not a refrigerant chamber that is under pressure.

1.6 Screws on indicator sensors

Before loosening sensor screws, one must first ascertain whether the screw has or does not have an immersion sleeve. In the latter case, loosening the screw will open the refrigerant chamber directly.

1.7 Unscrewing flanges

When opening flanges, do not loosen all screws at the same time. Leave at least two screws "kitty-corner" and before removing all screws check whether the connection is still under pressure. Use a gas mask and gloves.

1.8 Undercooled liquids in parts of the facility

When sections of the facility are opened during repairs and result in pressure equalisation with the atmosphere, it is impossible to know for sure that there is no liquid, undercooled ammonia remaining in the opened area. Ammonia has a very high heat of evaporation, so that the incoming heat, e.g. in pipes laid with a dead end trap, is not enough to quickly evaporate the liquid ammonia – especially if it is an insulated line. It's a different story for R 22, R 134a or R 404a, where the heat of evaporation – with regard to ammonia – is below 20 percent. Therefore, much less time is required to evaporate any remaining liquid. The BGR 500, chapter 2.35 explicitly mentions this danger.

2. Characteristics of ammonia

- Ammonia is present in both liquid and gaseous states in a refrigeration plant.
- Liquid ammonia may escape during a leak. The attendant evaporation causes larger volumes of vapour to be released.
- The wearing of protective mask and protective gloves during maintenance work minimizes the possibility of health risks.
- Ammonia vapour is lighter than air and rises to the top. However, part of the vapour mingles with the humidity and sinks to the bottom as liquid ammonia aerosol – visible as a white mist.

- Ammonia is flammable. However, it burns only if there is a supporting flame; an ammonia flame on its own will always go out again. The explosion thresholds are high and close together – between 15 and 35 percent by volume. The combustion rate is slow.
- The national accident prevention regulation BGR 500 stipulates no special explosion control requirements for electrical equipment in refrigeration units using ammonia. Danger is only an issue in a non-ventilated room of a building, if the concentration exceeds the lower explosion threshold at 105 grams per cubic meter and high-energy ignition sources are present.
- Ammonia is absorbed by water. Therefore water curtains are used to contain ammonia leaks, to damp down vaporous ammonia. One cubic metre of water can bind roughly 120 kilograms of ammonia, depending on the temperature. However, never sprinkle water onto liquid ammonia, as this will result in strong gas formation and the spattering about of liquid ammonia.
- Do not use water in engine rooms.
- Liquid ammonia may not be piped into bodies of water or the sewage system.
- Maintenance instructions should be easy and intelligibly written and should be practiced constantly.

3. Measures to take when an incident has occurred

- Try to ascertain the size of the leak.
- If it is likely that the room may be entered wearing a gas mask, then
    - Turn on the emergency ventilation before entering the room and
    - Turn off the liquid ammonia feed.
- If there is even the slightest suspicion that there may be an injured party in the ammonia area, sound the alarm. First get the people out of danger, then remedy the leak. Close all doors to the room from which the gas is leaking.
- Hit the emergency stop switch. This turns off valves, engines and other components in order to prevent the leaking of larger volumes of ammonia.
- If there is a gas warning system in place, the engine room ventilation should be set according to the alert thresholds. Apart from this, the ventilation should also have manual controls. From 50 kilogram capacity of ammonia, a gas warning system is required.
- If no gas warning system is in place, the ventilator is set manually, whereby it should be decided on a case by case basis whether it is still permissible to switch on the ventilator in case of a major ammonia leak (offensive smell in the vicinity).

- Close stop valves section by section if possible, especially on the liquid side, so that the volume of ammonia in the leak area is kept to a minimum. If possible, pump all the refrigerant out of that part of the system, moving it to other parts of the system. Here, too, take care not to trap any liquid refrigerant through shutting off parts of the system.
- If an ammonia puddle has formed in a collection basin or on the floor during the leak, the transmission of heat to these liquids and subsequent vapour formation can be nearly entirely halted by covering it up with foil (e.g. PE) or synthetic foam (fire department), which will provide enough time for taking measures to dispose of it.

4. Instructions

- Liquid ammonia can cause freeze burns or caustic damage to the skin and eyes.
- The injured person has to keep the protective mask on for the time being to prevent him from breathing in vapours from ammonia-soaked items of clothing.
- An ammonia victim should be showered with water for five to fifteen minutes.
- Remove clothing carefully while showering.
- If ammonia-soaked clothing is removed without the flow of water, the injury may be exacerbated as skin frozen to the clothing may be torn off.
- To prevent thermal shock, the shower should be with warm water if possible.
- A safety shower would be ideal. If there is none, use a water hose.

5. Effects on the surrounding environment

- Escaping ammonia may be borne into the vicinity by wind.
- Ammonia is lighter than air and rises quickly. The air dilutes it to harmless concentrations.
- The ammonia odour may be unpleasant even at harmless concentrations.
- People who live in the vicinity may be alarmed by an overrating of the term “toxic/poisonous.”
- It is recommended that people stay at home and close all doors and windows. The area does not need to be evacuated.
- Strong ammonia leaks into the wastewater system, e.g. when ammonia vapours are damped down by water, must immediately be reported to the authority in charge of the local sewage facility.

However, the correct manufacture of the system according to regulations, regular inspections of the system components and the high level of expertise of everyone involved, in practice incidents hardly ever happen. According to Germany's Central Office for Monitoring and Evaluating Accidents (ZEMA), in 2008 there was just one incident involving ammonia in Germany.

In case of doubt, the German-language original should be consulted as the authoritative text.

Published by *eurammon*
P. O. Box 71 08 64◆ D-60498 Frankfurt
Phone +49 69 6603 1277 ◆ Fax +49 69 6603 2276
e-mail: karin.jahn@eurammon.com
http://www.eurammon.com